Annual Project Summary

PALEOSEISMIC INVESTIGATION OF THE MOHAWK VALLEY FAULT ZONE, SIERRA COUNTY, NORTHEASTERN CALIFORNIA

U.S. Geological Survey National Earthquake Hazards Reduction Program
Award 04HQGR0089 (to Piedmont GeoSciences, Inc.)

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Program Element:
Element I—Earthquake Hazards Assessments

Key Words: Trench Investigation; Regional Seismic Hazards; Quaternary Fault Behavior; Age Dating; Paleoseismology

INTRODUCTION

The Mohawk Valley fault zone (MVFZ) lies along the western edge of the Basin and Range/Sierra Nevada transition and of the northern Walker Lane belt (NWL). Recent GPS geodetic measurements indicate that 4-8 mm/year of NW-directed, right-lateral shear occurs across a narrow zone directly east of the Sierra Nevada (Thatcher et al., 1999; Bennett et al., 1998, 1999; Svarc et al., 2002), over an area corresponding to the NWL. However, there is factor of 2 to 4 deficit between geodetic strain rates and geologic slip rates in the NWL. Thus, the MVFZ not only poses a seismic hazard for the Reno-Truckee region, it is important in the consideration of geodetic versus geologic rates.

The 60+ km long, NW-striking MVFZ exhibits geomorphic and paleoseismic evidence of late Quaternary right-lateral and normal surface faulting. Sub-parallel faults of the southern MVFZ bound the Sierran front and cross Mohawk and Sierra valleys. Geologic, paleoseismic and geomorphic evidence show a predominance of normal faulting on the prominent rangefront branch of the MVFZ. Normal offsets of Miocene and Pliocene volcanics (e.g., Page and Sawyer, 1992; 2002) constrain a long-term vertical slip rate

of 0.2-0.4 mm/yr on the western rangefront branch, assuming that vertical movement began at 3 Ma (Henry and Perkins, 2001; Wakabayashi and Sawyer, 2001). Multiple late Quaternary surface-faulting events have been documented on the range-front branch by a previous paleoseismic study (Sawyer et al., 1993).

In contrast, right-lateral strike-slip faulting has been inferred on subparallel intrabasin eastern branch based on the linear NW-trend of scarps, tonal and vegetation lineaments, deflected and beheaded drainages, the presence of sag pond and localized uplifts on the floors Sierra and Mohawk valleys (Sawyer et al., 1993; Grose, 2000).

The geometry of sub-parallel normal and strike-slip fault strands is repeated throughout the Walker Lane belt (e.g., Owens Valley, Panamint Valley, Death Valley, and Honey Lake Valley) and reflects strain partitioning between Basin and Range extension and plate-boundary related shear (Wesnousky and Jones, 1994).

The present investigation focuses on the eastern branch of the MVFZ where it crosses the floor of southern Sierra Valley. The specific research goals are to constrain the recency and recurrence of paleoearthquakes, and the rate of lateral slip on the eastern branch fault.

INVESTIGATIONS UNDERTAKEN

To date, we have excavated 4 trenches across and 5 trenches parallel to this intravalley trace of the MVFZ. The trench walls were cleaned, flagged, surveyed, photographed, and logged. The trenches exposed a sequence of alluvial and aeolian(?) deposits, a possible tephra layer, buried soils, detrital wood and charcoal, and several high-angle faults. The recently active faults are the western-most faults exposed in the cross-strike trenches, and they tend to bound fissures containing multiple packages of chaotic fill. A number of older faults were truncated by a period of erosion represented by an unconformity in the lower exposed section. Radiocarbon and tephra samples have been collected from the exposures and submitted for analyses, and should constrain the age of trench units, and the paleoearthquake history and rate of slip on the eastern branch of the MVFZ.

Considerable effort has been made to identify and correlate a buried stream channel across the fault to constrain amounts and rates of lateral displacement. The channel crosses the fault at a very oblique angle, probably as a result of stream deflection. Only by creating numerous hand-excavated exposures, sequentially slicing back trench walls to provide detailed 3-D survey control on stratigraphic/fault relationships, were we able to trace the western margin of the channel directly to its intersection with the fault on both sides of the fault, thus eliminating uncertainty associated with projections.

In addition, we have conducted a formal peer review of the trench exposures, two aerial reconnaissance flights of the MVFZ (at no cost to NEHRP), and are in the process of mapping the fault from stereoscopic interpretation of aerial photographs and field reconnaissance.

Preliminary Findings

Preliminary findings based on the ongoing trench investigation of the MVFZ include the following:

1) The east branch of the MVFZ is defined by scarplets, vegetation and tonal lineaments, beheaded and deflected drainage channels; and shallow groundwater barriers;
2) Trench relationships are interpreted to support a paleoseismic history of at least four late Quaternary surface-rupturing paleoearthquakes, as well as a paleoliquefaction event that may or may not have been on the MVFZ. The three most recent events are believed to have occurred during the Holocene, pending the radiocarbon dates;
3) The 3-D trench exposures and survey data constrain the channel margin to be offset approximately 2.7 m in a right-lateral sense and 0.65 m, down to the west, in a normal sense. These data provide a lateral-to-vertical slip ratio of 4:1 and a net slip measurement of approximately 2.78 m;
4) The lateral offset of the channel is associated with the three most-recent events documented on the fault, indicating slightly less than 1 m offset per event at this site near the southern end of the fault; and
5) We anticipate that radiocarbon dates and possibly tephrochronology will constrain the paleoearthquake history and rate of lateral slip on the MVFZ.

WORK TO BE COMPLETED

The remaining tasks to be accomplished are to: 1) Further analyze findings and data from the paleoseismic investigation; 2) establish age constraints for offset channel deposits based on radiocarbon dates and possibly tephrochronology; 3) conducted additional photogeologic mapping and field reconnaissance of the MVFZ; and 4) prepare and submit to the U.S. Geological Survey the final technical report. The report will include a regional map of the MVFZ, detailed trench logs, a site map, and discussions of methodology, results and associated uncertainties, and conclusions.

Non-Technical Project Summary

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Non-Technical Summary

The goal of this study is to document the history of earthquakes and rate of movement on the Mohawk Valley fault zone, a potentially significant source of large-magnitude (M≈7) earthquakes for the Reno-Truckee area. Preliminary findings indicate that the Mohawk Valley fault zone is an active earthquake source that has a higher degree of activity than previously believed. These findings contribute to a better understanding of seismic hazards in western Nevada and eastern California. We intend to publish the results of this investigation in an effort to reduce earthquake risk.

References

Bennett, R.A., B.P. Wernicke, and J.L. Davis, 1998. Continuous GPS measurements of contemporary deformation across the northern Basin and Range province. Geophys. Res. Letters 25:4, pp 563566.

Bennett, R.A., Wernicke, B.P., Davis, J.L., Friedrich, A., and Niemi, N.A., 1999. Distribution of extension and shear across the northern Basin and Range from BARGEN continuous GPS data: The fate of the eastern California shear zone. Eos, Transactions, American Geophysical Union, vol.80, no.46, pp. F269.

Grose, T.L.T., 2000, Geologic map of the Sierraville 15' Quadrangle, Sierra and Plumas Counties, California: California Division of Mines and Geology, scale 1:62,500.

Henry, C.D. and Perkins, M.E., 2001, Sierra Nevada-Basin and Range transition near Reno, Nevada: Two-stage Development at 12 and 3 Ma: Geology, v. 29, no. 8, p. 719-722.

Page, W.D., and Sawyer, T.L., 2002, Use of geomorphic profiling to identify Quaternary faults within the Northern and central Sierra Nevada, California: in H. Ferriz, and R. Anderson, eds., Engineering Geology Practice in Northern California, California Geological Survey Bulletin 210/Association of Engineering Geologist Special Publication 12.

Sawyer, T.L., Page, W.D., and Hemphill-Haley, M.A., 1993. Recurrent late Quaternary surface faulting along the southern Mohawk Valley fault zone, NE California. Geological Society of America, Abstracts with Programs, v. 25, p. 142.

Svarc, J.L., Savage, J.C., Prescott, W.H., and A.R. Ramelli, 2002. Strain accumulation and rotation in western Nevada, 1993 – 2000. Jour. Geophys. Res., 107, B5, ETG 2-1 – ETG 2-11.

Thatcher, W., G.R. Foulger, B.R. Julian, J. Svarc, E. Quilty, and G.W. Bawden, 1999. Present-Day Deformation Across the Basin and Range Province, Western United States. Science, Vol. 283.

Wakabayashi, J. and Sawyer, T.L., 2001, Stream incision, tectonics, uplift, and evolution of topography of the Sierra Nevada, California: Journal of Geology, vol. 109, p. 539-562.

Wesnousky, S. G., and C. H. Jones, 1994. Slip partitioning, spatial and temporal changes in the regional stress field, and the relative strength of active faults in the Basin and Range, Geology, 22, 10311034.

Zdanowicz, C.M., Zielinski, G.A., and Germani, M.S., 1999, Mount Mazama eruption: Calendrical age verified and atmospheric impact assessment: Geology, v. 27, p. 621-624.